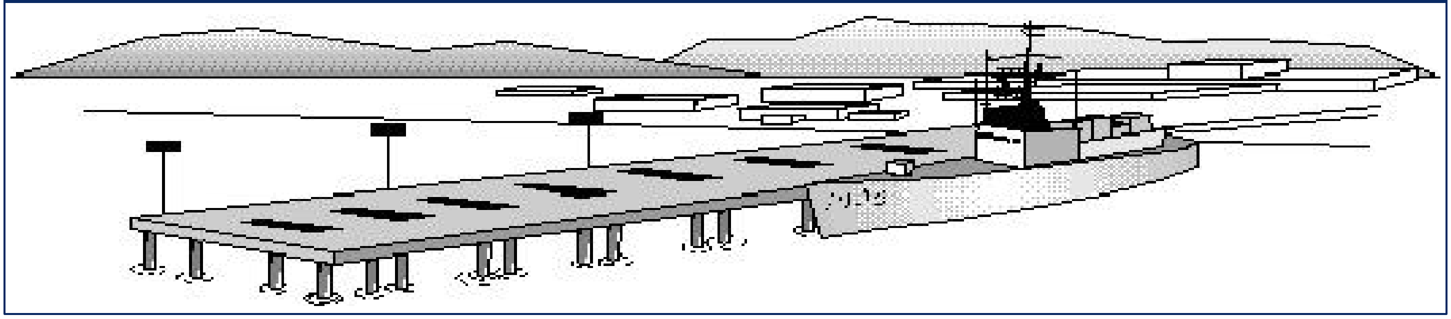
N F E S C

Naval Facilities Engineering Service Center
1100 23rd Avenue
Port Hueneme, CA 93043-4370

On The Waterfront

A Publication of the Shore Facilities Department

Volume 1.7



Repairs Increase Capacity of Wharf Without Interrupting Operations

NFESC engineers recently worked with personnel from **NAVSTA Pearl Harbor, PWC Pearl Harbor**, and **PACDIV** to provide additional deck capacity **for Wharf B25 at NAVSTA Pearl Harbor.** The capacity was provided by applying Carbon Fiber Reinforced Plastic (CFRP) to the upper and lower surfaces of the wharf decks. The CFRP was installed without interruption to wharf operations. Alternative, more costly solutions, such as increasing the deck thickness or replacing the deck, would have taken the wharf out of service for a year. The project also included the installation of an integrated forced current cathodic protection system to extend the life of the reinforcing steel. **RADM (sel) Michael Loose**, Commanding Officer, PWC Pearl Harbor, stated that the work "...far exceeded our expectations" in an email to **Dr. George Warren**, the Shore Facilities Department project leader.

The upgrade increased the capacity from 50-ton cranes to 70-ton cranes for 100 feet at each end of the berthing. It allowed the NAVSTA to extend the life of the wharf by 20 years. The project demonstrated the performance of CFRP external reinforcement and instrumentation in a tropical environment and demonstrated the capabilities of cathodic protection systems. The knowledge gained will be used to extend the life and increase the capacity of waterfront facilities at Naval activities around the world.

Wharf Bravo 25 at NAVSTA Pearl Harbor, HI.

Wharf B25 was built in 1949, is 37 feet wide, and has an 8.5-inch thick deck. The wharf was originally designed to support cargo loading by rail car or track mounted cranes.

The project, initiated after a structural assessment by NFESC, showed that a small addition of reinforcement would significantly enhance the performance of the wharf. A finite element analysis model of the wharf was developed and coupled to measure deflection response using NFESC's impact load method. NFESC engineers used the test results to fine-tune the FEM model to make it accurately reflect the current condition of the wharf. The model allowed them to determine the required reinforcement to increase the capacity by as much as 78 percent.

NFESC engineers worked with the Staff Civil Engineer, PACDIV, and the ROICC during the upgrade design, application of the FRP, and to proof test the finished structure. Critical participants were **Ms. Jill Kaya** and **Mr. Randy Tanaka** of the staff civil office, **Mr. Wayne Acosta** of PACDIV, **Ms. Ann Saki-Eli** of the PACDIV contracts office, **LT Mahelo Stephenson** from the ROICC office, and **Mr. Fred Ching** from PWC.

First, existing rails were removed from the top of the deck. Abrasive blasting and chipping hammers were used to create uniform surfaces on both the top and bottom surfaces. **Mr. Doug Burke**, of

(continued on page 2)

(continued from page 1)

the Waterfront Materials Division, directed the repair of the concrete as well as sealing cracks with silicon filler and backer rod. Next, 3/8-inch carbon rods were embedded into slots cut into the top surface of the deck under the direction of **Mr. Steve Harwell** of the Waterfront Structures Division. The rods were sealed in place with epoxy and covered with ultraviolet protection. CFRP tow sheets were applied to strengthen the bottom surface of the deck under the direction of **Mr. Dave Hoy** of the Waterfront Materials division.

Placing CFRP rods in wharf deck.

Multiple layers were placed and fastened with an epoxy matrix.

The project also included a corrosion arrestment system that was integrated with the structural upgrade. The system, put in place by **Mr. Dan Polly** and **Mr. Tom Tehada** of the Waterfront Materials Division, consisted of embedded titanium ribbon that acted as anodes

Welding anode ribbon and header of cathodic protection system.

to impress a direct current on the rebars to reverse the corrosion cell. Use of this methodology will provide corrosion protection for the entire concrete structure.

Other articles describing the use of composites to upgrade waterfront structures can be found in our on-line file cabinet at ***www.nfesc.navy.mil/shore/filecabinet.html***. For more information about using composites to upgrade facilities, contact **Dr. George Warren,** ESC62, at DSN 551-1236, comm. (805) 982-1236, or email: warrenge@nfesc.navy.mil.

For more information about cathodic protection systems, contact **Mr. Dan Polly**, ESC63, at DSN 551-1058, comm. (805) 982-1058, or email: pollydr@nfesc.navy.mil or **Mr. Tom Tehada**, ESC63, at (808) 474-5360, or email: tehadatj@nfesc.navy.mil.

SOMETHING NEW!!

Starting with this issue, we're delivering **"On The Waterfront"** by email as well as ground mail. Here's how it works:

Each time an issue is published, an email will be sent to each subscriber containing a brief summary of the issue's contents and a PDF copy of the issue (each issue is approximately 500kb). The free PDF file viewer is available at www.adobe.com/prodindex/acrobat/readstep.html. Issues will still be distributed through ground mail and copies of the current and back issues will continue to be available on our web site at **www.nfesc.navy.mil/shore/otw.htm**.

To subscribe, send an email to **otw-request@lists.nfesc.navy.mil** with the word "subscribe" in the body of the message, or subscribe through the web at www.nfesc.navy.mil/shore/otw.htm.

Back Issues of
"**On The Waterfront**"
are avaiable through
the Shore Facilities
web page at:
www.nfesc.navy.mil/shore/otw.htm

"**On The Waterfront**" is an unofficial publication of the Shore Facilities Department, Naval Facilities Engineering Service Center, Port Hueneme, CA 93043-4370. Editorial views and opinions are those of the authors and not necessarily those of the United States Navy.

If you have any comments or questions, suggestions for future articles, or would like to receive copies of "**On the Waterfront**," call or write to **Joe Connett, Code ESC60APM, (805) 982-1570; DSN: 551-1570; FAX: (805) 982-3481, or Email: connetja@nfesc.navy.mil.**

Did You Know...

About the AWTTS?

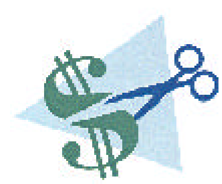
FRP concept evaluation at the AWTTS.

The performance of the CFRP sheets, and their ability to strengthen waterfront structures was first measured at NFESC's Advanced Waterfront Technology Test Site (AWTTS). The AWTTS is a 150-foot scale model of a waterfront pier located at the Naval Construction Battalion Center (CBC), Port Hueneme, California - home of the NFESC. The AWTTS serves as a national center for the development, evaluation, and demonstration of new concepts and materials for upgrade, repair, and life extension of waterfront structures. It allows NFESC engineers to apply advanced materials in an accurate simulation of the conditions experienced in the field. The AWTTS, in combination with NFESC laboratories, allows NFESC engineers to determine and evaluate the properties and performance of waterfront materials. The knowledge they gain enables them to make the best decisions on the use of the technologies to enhance Naval activities. For more information about the AWTTS, contact **Mr. Bob Odello**, ESC62, at DSN 551-1237, comm. (805) 982-1237, or email: odellorj@nfesc.navy.mil.

New Technologies Cut the Cost of Naval Facilities

New technologies can cut the cost of ownership of Naval facilities and thus help the Navy reduce the cost of ownership of weapons systems. In the first year of the 5-year, RPM DEMVAL Program, Shore Facilities engineers and scientists, in partnership with other members of NAVFAC, field activities, industry groups, and commercial vendors, identified, planned, and implemented technology demonstrations and validation projects. The first four projects alone show the potential to cut facilities costs by $500,000 per year in addition to increasing operational efficiency and cutting operational costs. Visit the Shore Facilities web page at ***www.nfesc.navy.mil/shore/demval.htm*** for more information about the RPM DEMVAL program, potential technologies, and projects underway.

During FY00, the second year of this CNO N44 sponsored program, Shore Facilities will be continuing and expanding the technology evaluations. We identify technologies by looking to industry, academia, and other government services for promising technologies. We match that "technology push" with a "client pull" by examining BASEREPS and asking members of Naval activities and NAVFAC Public Works Centers and Engineering Field Divisions to identify problems which might be addressed through technologies. We have recently received suggestions from **CDR Dave Balk**, at **NAS Yuma** (through **Ms. Kim Naylor**: the SWDIV Activity Liaison Officer for Yuma); **Mr. Joe Brandon** at **LANTDIV**; **Ms. Lisa Arrieta** at **NSWC Coastal Systems Station, Panama City**; **Mr. Myles Nahamura**, **PACDIV**; and **Mr. John Lynch**, at the **NAVFAC Criteria Office** at **LANTDIV**, that are being considered for next year's projects. Over 40 potential technologies were identified last year. NFESC in cooperation with the **Civil Engineering Research Foundation (CERF),** selected those that showed the greatest promise for demonstration though incorporation in activity projects.



The ultimate goal is to accelerate the widespread validation, commercialization, and implementation of the technologies throughout the Navy. RPM DEMVAL helps activities save two ways - first, by facilitating the implementation of new technologies which will reduce life cycle costs, and second, though cost-sharing opportunities which allow NFESC to supplement activity expenses with funding to help pay the cost of the technology implementation.

Four technologies were selected for demonstration during the first year of the program. They are:

- **F/A-18 Exhaust Resistant Pavement Systems**. Pavement identified through NFESC research can withstand many times more F/A-18 cycles than Navy standard concrete pavement constructed with Portland cement. The greater endurance enables the pavement to reduce the threat of foreign object damage (FOD) to the F/A-18s from spalled pavement. The pavement also has a life up to 4 times longer than traditional pavements and a lifecycle cost 62% lower. The research behind this technology is described in TechData Sheet TDS-2058-SHR, located in our file cabinet on our web page at www.nfesc.navy.mil/shore/files/2058tds.pdf. **Mr. Doug Burke** of our Waterfront Materials Division and **Mr. Terry Riley** and **Ms. Ellen Freihofer** of **LANTDIV** are currently setting up a field demonstration of the pavements at **NAS Oceana**.

- **Floor Coatings for Aircraft Hangars**. To successfully coat a hangar floor requires degreasing of hydrocarbon

(continued on page 4)

(continued from page 3)

The exhaust from an F/A-18 Auxiliary Power Unit, in combination with spilled Skydol jet fluid, can cause ordinary concrete pavement to spall in as little as 6 months.

contaminated concrete (e.g., oil, fuels, Skydrol, ect.), removal of weak surface cement, specifying high performance coatings and joint sealent, and proper application. Commercially available coating systems combine epoxy and urethane coatings at the following thicknesses:

- Thin film - ≥ 16 mils: 1 mil = 0.001-inch
- Medium film ≥ 20 mils
- Thick film ≥ 250 mils

A concrete condition assessment is required to determine whether a hangar floor surface is suitable to receive a coating system. **Mr. Dave Gaughen** of our Waterfront Materials Division is the technical lead for this project. Another article in this issue describes the implementation of these technologies at Naval activities.

- **Moisture Cured Urethanes.** Moisture cured urethanes (MCU) are single component coatings that can be applied to a wide range of Navy structures. They cure by reacting with moisture in the air making them ideal for many Naval environments. They will serve as substitutes for other coatings which also conform to environmental restrictions, but have higher costs and lower durabilities. **Mr. Dan Zarate** of the Waterfront Materials Division, the Navy's Coatings Technical Consultant, is managing this project. He is working with **Mr. Paul Vernon** at **NSWC Point Mugu** on a project to recoat hangar PM372 to validate the field performance of the urethanes.

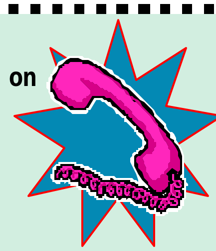
- **Roof Asset Management.** This project will demonstrate an integrated roofing management program. The program will establish the roles of Navy engineers and contracting specialists, A&Es, and maintenance contractors and include evaluation of processes for acquisition, QA/QC, inspection, and maintenance of low sloped roofing. The Navy's Roofing Technical Consultant, **Mr. Mark DeOgburn,** of our Waterfront Materials Division, is managing the project. This year, with the help of **Mr. Dennis Blackwell, NWS Charleston**, the **PWC Jacksonville** field office awarded a contract for inspection of all low sloped roofs at NWS Charleston. The inspections will establish a baseline of roof conditions to allow measurement and evaluation of improvements made to roof asset management.

The Navy owns over 818 million square feet of low sloped roofing. Their average life is 7 years - approximately 1/3 the average industry life of 20 years.

Over 40 technologies are currently being considered for demonstration and validation during the next round of RPM DEMVAL. The final selection of technologies will be made in the first quarter of FY00 and will be announced on our RPM DEMVAL web page. One technology that has already been selected for funding is the use of high volumes of fly ash in concrete, and is presented in another article in this issue.

For more information, contact **Mr. Joe Connett**, ESC60APM, at comm. 805-982-1570, DSN 551-1570, or email: connetja@nfesc.navy.mil, or any of the project leads listed in the RPM DEMVAL web page at ***www.nfesc.navy.mil/shore/demval.htm***.

Want more information on how to put NFESC to work for you?



Call us at

1-888-4 THE ESC (1-888-484-3372)

E-mail us at help@nfesc.navy.mil

or join us on the Web at

www.nfesc.navy.mil

Improved Surface Preparation, Floor Coatings, and Joint Sealants for Aircraft Maintenance Facilities

Over the past three decades, Naval facilities have been marginally successful in specifying floor coatings for use in aircraft maintenance facilities which, in effect, has prevented the development of floor coating guidance. However, NFESC is confident that a combination of new concrete cleaning technologies followed by high performing floor coatings will result in flooring systems with increased service life.

OPNAV N44, through NAVFAC and NFESC, has initiated a multiyear program designed to Demonstrate/Validate (DEMVAL) commercially available technologies, which can reduce the cost of repairing and maintaining the Navy's shore facilities. One of the first projects under this program is the DEMVAL of "Coating Systems and Joint Sealants for Aircraft Maintenance Facility Floors." The project leader is **Mr. Dave Gaughen** of the Waterfront Materials Division.

Failing hangar floor coating system due to poor resistance to aircraft solvents.

Concrete surfaces, including joints, must be properly cleaned and abraded prior to the application of coatings and sealants. Several surface preparation technologies have been demonstrated on concrete floors located at **Naval Air Station Joint Reserve Base (NAS JRB) Dallas - Fort Worth, Texas**. **Mr. Wes Cloud**, the **Maintenance Control Director** and **LCDR Greg Simmons**, **Commanding Officer**, **Public Works**, provided two sites for the demonstration:

- A 1,700-square foot Electronic Equipment Maintenance Shop
- An 18,000-square foot F/A–18 Maintenance Hangar

The maintenance shop contained linoleum tile, tile adhesives, and concrete contaminated to a depth of 0.5-inch with fuels, Skydrol and other residual coolant fluid. The maintenance hangar contained 30 mils (1 mil = 1/1,000-inch) of a coating system over concrete contaminated to a depth of 30 mils with fuels, oils, and Skydrol. Seven cleaning technologies were demonstrated:

- Mechanical and hand tool chipping

Removal of joint sealants from an F/A-18 hangar.

- Organic solvent degreasing
- Aqueous-based alkaline degreasing
- High pressure/hot water degreasing
- Shot blasting
- Diamond disk power grinding
- Hand tool scraping and cleaning

The results of these demonstrations indicate that the cleaning technologies, when combined in various orders and combinations, cleaned the contaminated concrete to a degree acceptable to promote maximum coating and sealant adhesion.

In addition to evaluating cleaning technologies, NFESC is conducting an on-site performance survey of commercially used hangar floor coating systems and joint sealants. The survey enables NFESC to evaluate both coating systems and joint sealants employed by aircraft manufacturers and airline maintenance facilities. Survey results will be used to aid NFESC in selecting high performing coating systems scheduled for field demonstration in FY00.

Three separate field demonstrations at **NAVSTA Roosevelt Roads Puerto Rico**, **NAF Misawa Japan**, and **NAS JRB Dallas-Fort Worth**, are scheduled to take place in FY00. The performance of the coating systems and joint sealants will be evaluated annually starting 1 year after application and will continue for approximately 3 years. If the coating systems demonstrate high performance, then the following guidance documents will be generated:

- How to Assess the Condition of Concrete Floors Prior to Coating
- Thin Film Coating System for Hangar Floors
- Medium Film Coating System for Hangar Floors
- Thick Film Coating System for Hangar Floors
- Overcoating Sound Hangar Floor Coatings
- Thick and Thin Film Coating Systems for Maintenance Shops
- How to Clean and Maintain Floor Coatings

For further information, contact **Mr. Dave Gaughen** at DSN 551-1065, comm. (805) 982–1065 or email: gaughencd@nfesc.navy.mil.

Use of 30 Percent Fly Ash in Concrete Provides Economic and Environmental Benefits

Under the RPM DEMVAL Program, NFESC has started a 3-year project to demonstrate construction of Navy concrete facilities using up to 30 percent fly ash as a partial replacement to Portland cement. A new runway at **NAS Point Mugu**, California, is the first project to use this new technology. **Mr. Dave Mades**, **Project Manager**, **Mr Ed Trask**, **Director of Engineering**, and **Mr. Bill Crowley**, **Quality Assurance Representative**, from Point Mugu teamed with NFESC engineers to demonstrate the use of concrete mixtures containing high quantities of fly ash.

Placing 100 cubic yards of concrete per hour with 30 percent Class F fly ash.

Fly ash is collected in the filtering systems that remove particles from the exhaust gases of coal-fired power plants. Fly ash as a pozzolanic material for use in concrete was identified as early as 1914. It reacts with calcium hydroxide to improve the long-term durability of concrete. Since fly ash cost less than cement in California, the cost of the ready mix concrete was reduced from $85 per cubic yard to $80 per cubic yard for the runway project. The technology promises many benefits including:

- Improved long term durability
- Improved workability of fresh concrete
- Lower construction costs

In addition to improving concrete performance, using higher amounts of fly ash has many important environmental benefits such as:

Proper curing is always critical to achieve quality concrete.

A 50- by 565-foot by 14-inch thick lighted aircraft carrier simulation deck located at NAS Point Mugu, California.

- Reduction in cement production, which reduces atmospheric pollution and global warming.
- Use of fly ash constitutes affirmative procurement of recovered materials as directed by EPA.

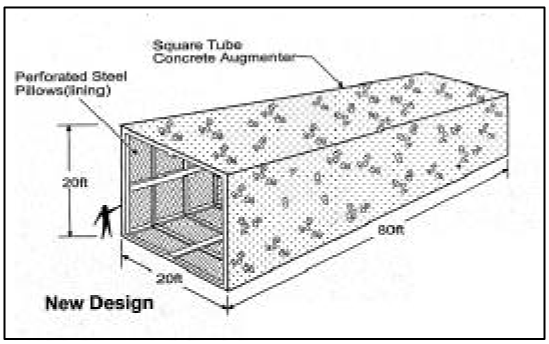
Experts on global warming link 7 percent of the world's carbon dioxide emissions to the procurement of Portland cement, a main concrete component. In the U.S., cement production accounts for about 2.4 percent of the total industrial and energy related CO_2 emissions. Cement production also accounts for 61 percent of industrial non-energy related carbon dioxide emission in the U.S. By significantly increasing the volume of fly ash used in concrete production, the Navy will significantly reduce cement consumption and save money. Each ton of cement that is eliminated will reduce carbon dioxide emissions by about 0.5-ton.

Night placement aids in reducing shrinkage cracks of joint free concrete, Runway #3S for E-2 Squadron.

NFESC is seeking interested Navy Activities who would like to construct concrete projects with high volumes of fly ash. The principal investigators for this effort are **Mr. Douglas Burke** at DSN 551-1055, comm. (805) 982-1055 or email: burkedf@nfesc.navy.mil, and **Dr. Javier Malvar** at DSN 551-1447, comm. (805) 982-1447 or email: malvarlj@nfesc.navy.mil.

Model Test Reduces Cost of New Augmenter Tube Design

Dr Tom Novinson of the Shore Facilities Waterfront Materials Division recently assisted **Mr. Vince Donnally** of the **NAVFAC Criteria Office** at **LANTDIV** by evaluating the thermal performance of materials for a new "square tube" jet engine test cell augmenter tube (JETCAT). The new JETCAT, designed to replace the current oval tube design, is scheduled for construction at **NAS Oceana** in 1999. NFESC's evaluation showed that the tube is adequate to withstand the design thermal loads from the jet engine test cell. The evaluation also showed that one of the materials included in the original design did not contribute to the tube performance. Elimination of this material reduced the cost of each JETCAT by approximately $300,000. In a letter of appreciation, **Mr. Phil Bolton**, head of the criteria office, stated, "…Because of Dr. Tom Novinson's contributions, the Navy avoided potential problems at NAS Oceana and will be able to provide more cost efficient jet engine test cells for future projects."

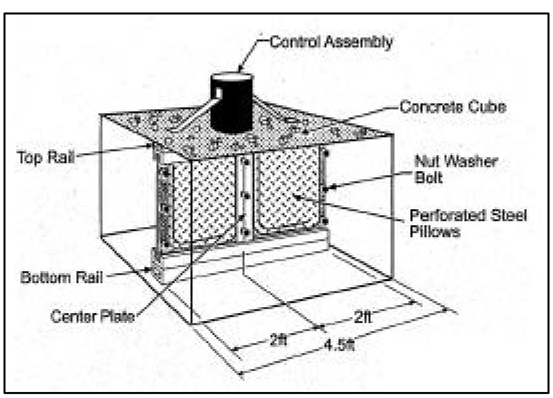


New augmenter tube design.

The JETCAT designed for NAS Oceana is an 80-foot long concrete square tunnel lined with 4- by 6-foot steel "pillows." The pillows are used for noise suppression. They are made from two sheets of perforated steel welded together to form a pocket. The pocket is filled with mineral wool and the pillow is sealed by welding. The pillows are held away from the concrete wall by a system of concrete extensions and slip joints that permit the pillows to expand when heated.

The jet engine exhaust gas temperature is about 500°F as it sweeps through the augmenter. NFESC's objective was to determine the effects of heating cycles (70°F to 500°F) on the ability of the design to protect the lightweight concrete wall from excess temperatures. The sponsor wanted to know if the slip joint design would operate successfully when loaded by the heating cycles and if the wall temperatures would reach levels which might result in cracking or spalling of the concrete. The sponsor also asked NFESC to evaluate the performance of an insulating mortar being considered for the design and to test the elasticity and strength of two types of washers being considered for the slip joint:

- Conventional split ring lock washer (1 per bolt)
- More expensive Belleville washers (6 per bolt)



Test model augmenter tube.

To study the heat transfer, NFESC built a 4- by 4- by 4.5-foot partial model concrete "E-shaped" cell with embedded thermocouples. The cell held two 2- by 2-foot pillows fastened to the concrete with the same concrete extension and slip joint configuration of nuts, bolts, and washers designed for the full size JETCAT.

Test model of augmenter tube.

The heat was provided from an NFESC "mock jet engine" gas burner used in high temperature pavement experiments. A steel "furnace box" was built to cover the open face of the cell. The hot exhaust gases were directed from the gas burner to the furnace by an insulated steel pipe. Only 2 to 3 minutes were required to heat up the interior of the furnace to the test temperature of 500 °F.

The tests validated the ability of the design to prevent unacceptably high thermal loads on the concrete. The test showed that the slip joint performed so the steel pillows did not misalign and did not warp, and that the Belleville washers outlasted the split ring lock washers. The tests also showed that the insulating mortar did not deliver the required performance. The material melted or sublimed during the heating process. Since the design behaved acceptably even after the material failed, NFESC determined that the material was not required to protect the concrete and it was consequently eliminated from the design.

For more information, contact **Dr. Thomas Novinson**, ESC63, at DSN 551-1056, commercial (805) 982-1056, or email: novisont@nfesc.navy.mil

On The Waterfront

In This Issue

MAILING LIST

- ☐ Please add me to the mailing list.
- ☐ Please add me to the e-mail distribution list.
- ☐ Please remove me from the mailing list.
- ☐ Please update my address.

Name ____________________

Title ____________________

Firm/Organization ____________________

Street ____________________

City__________ State______ Zip ______

E-mail ____________________

Fax or email to: Joe Connett (805) 982-3481, connettja@nfesc.navy.mil. To subscribe to email distribution, send an email with the word “subscribe” in the body to “otw-request@lists.nfesc.navy.mil.

DEPARTMENT OF THE NAVY

COMMANDING OFFICER
NFESC
1100 23RD AVE
PORT HUENEME CA 93043-4370

OFFICIAL BUSINESS